Body Dynamics Computer Modeling:

Prototyping of Safety Systems

and

Laboratory Tests

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Report Documentation Page

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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Modeling and Simulation: A Crashworthy Systems Perspective

1. How does the human body move during highly dynamic events?

2. What loads does the body experience?

3. How can motion be controlled and loads reduced to enhance safety and survivability?

Modeling and Simulation: Specifics for System or Experiment Prototyping

1. What limits on body motion are acceptable for a safety system?

2. What range-of-motion must be accommodated by a proposed test fixture?

3. What are the approximate peak loads on the body and the equipment?

4. For systems, how well do various approaches control motion and reduce loads?

5. For experiments, what safety precautions are needed to protect test dummies and equipment?

Understanding Motion: Kinematics Visualization is a Powerful Prototyping Tool

- Highly dynamic events are hard to visualize and comprehend because they are so beyond our everyday experience

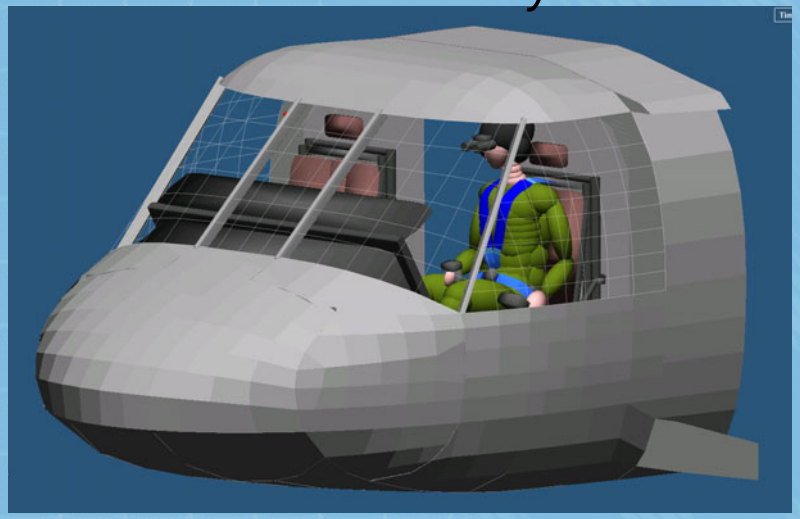
- Modeling lets us “experience” these events so that our search for safety improvements, or our experiment design, is bounded by actual kinematics

Simulation Examples: MADYMO™ Models

(Pictures and Videos Produced with the HyperView™ Postprocessor)

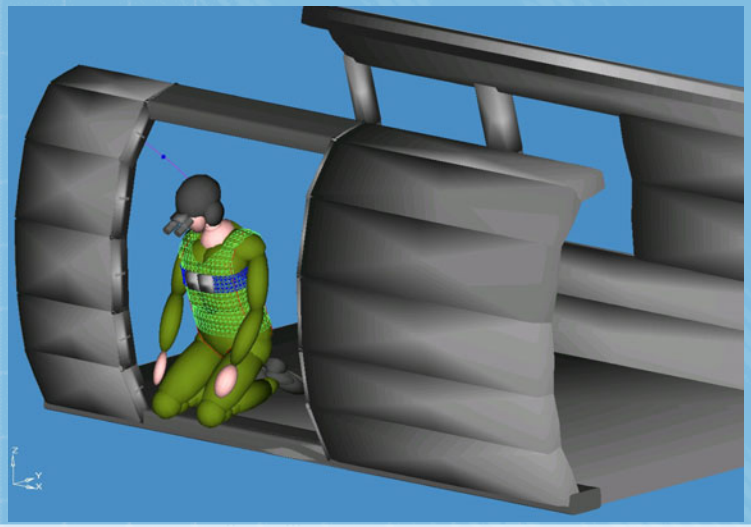
H-60 Cockpit & Pilot:

Crash Protection System



Ejection Seat Parachute Opening Snatch Loads:

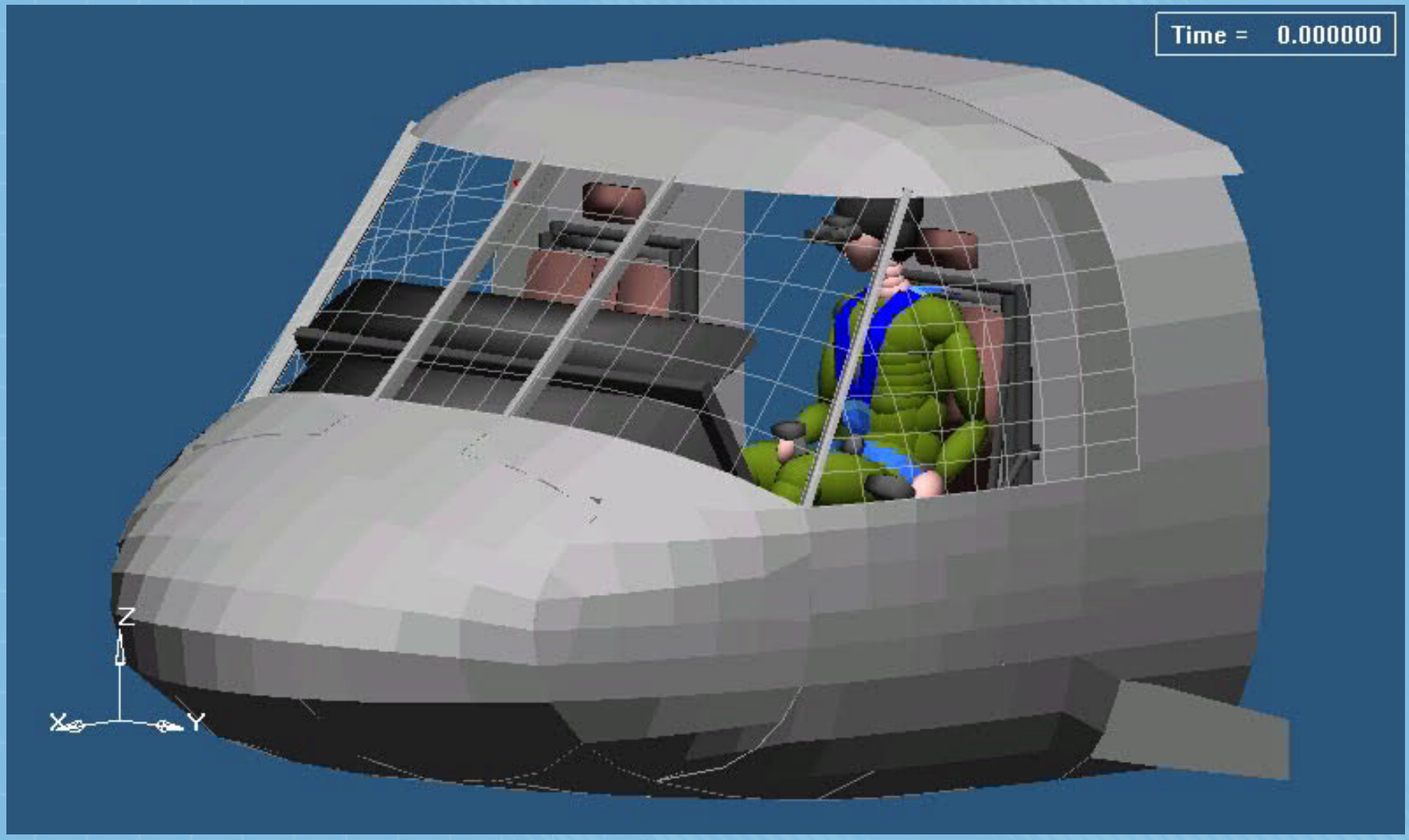
Horizontal Accelerator (HA) Test



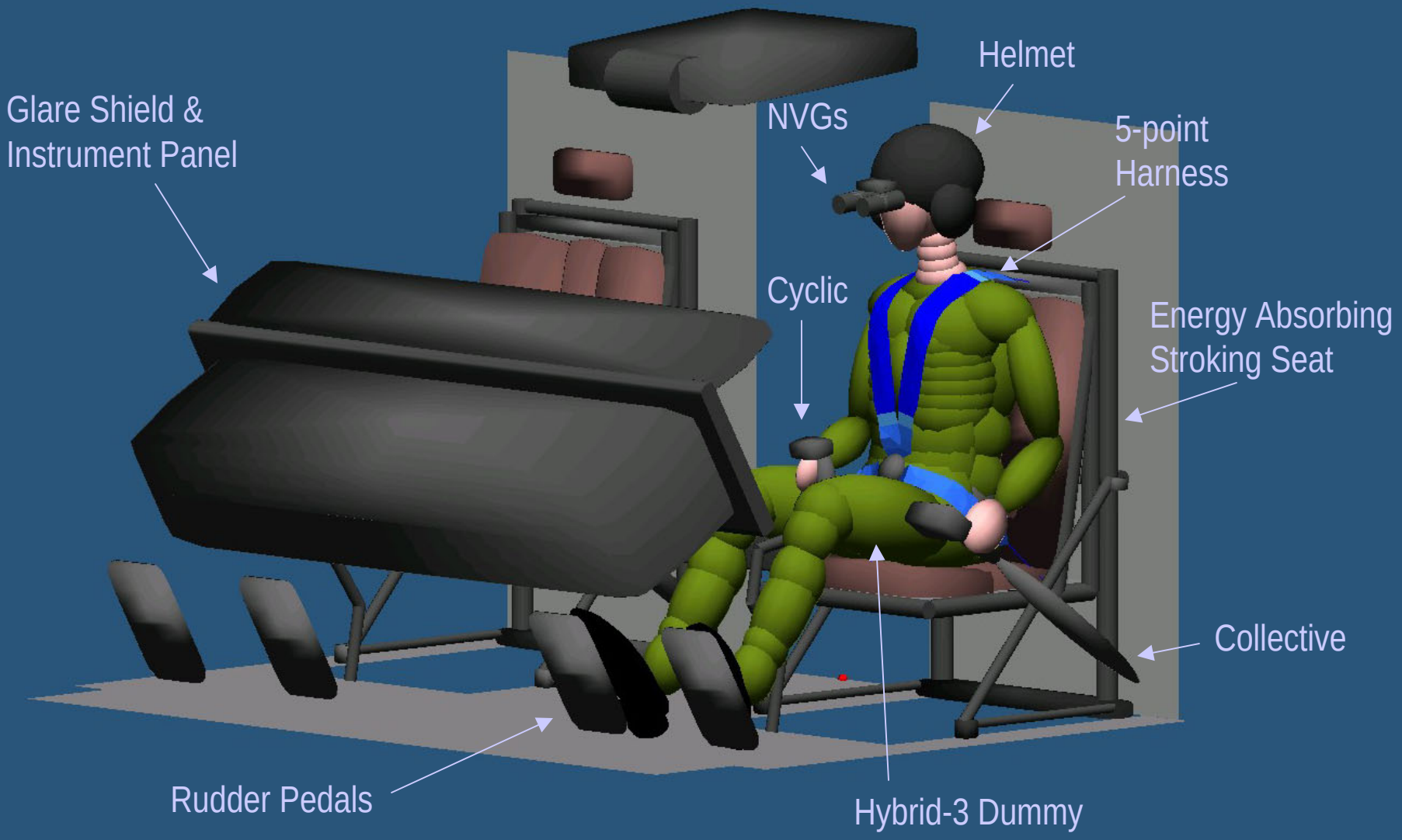
H-60 Cabin & Mobile Crewman:

Safety Tether System

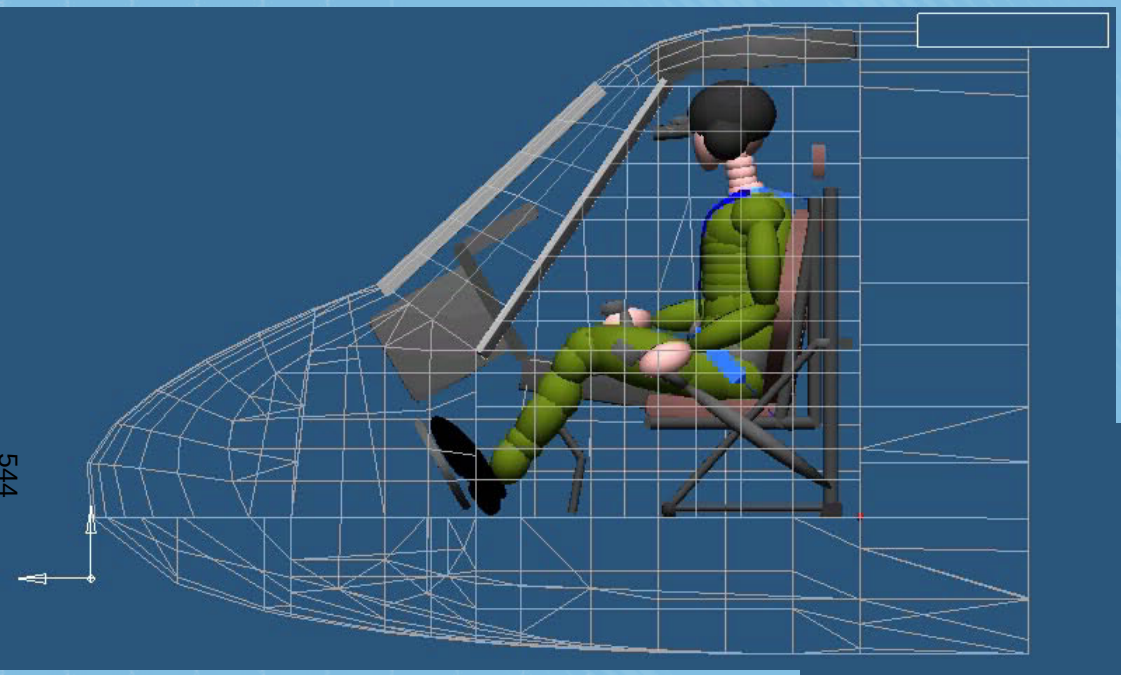
H-60 Cockpit & Pilot:
Crash Protection System



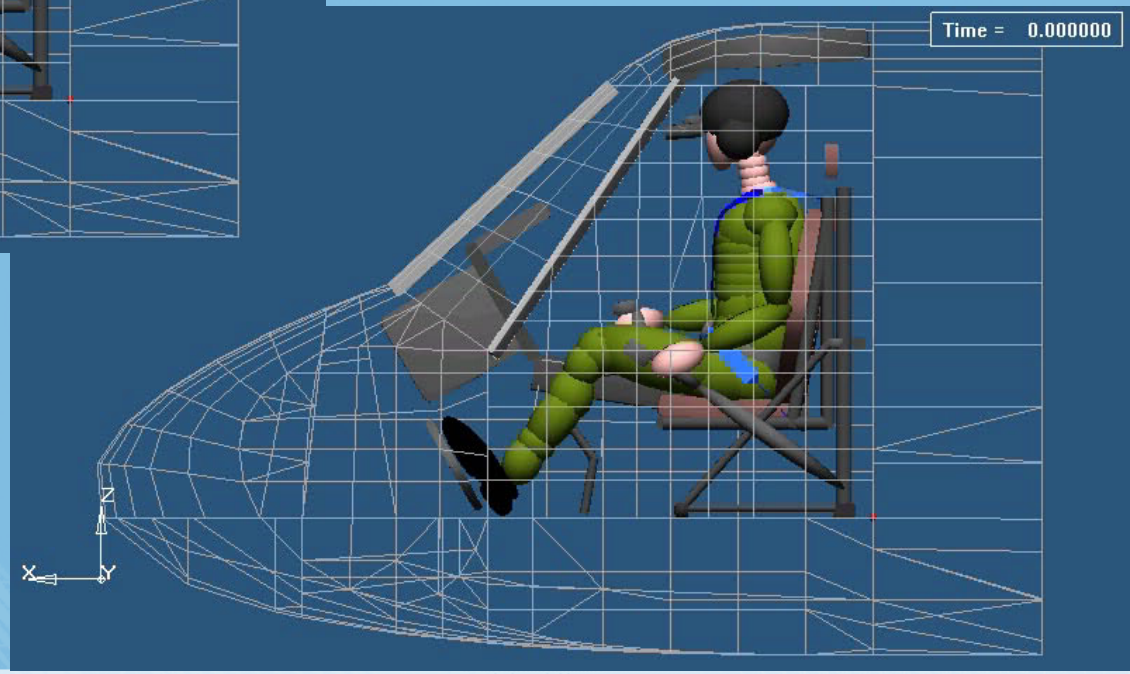
H-60 Cockpit & Pilot: Model Components



H-60 Cockpit & Pilot: Crash Protection System Performance in a 36G, 30° Pitch-down Crash

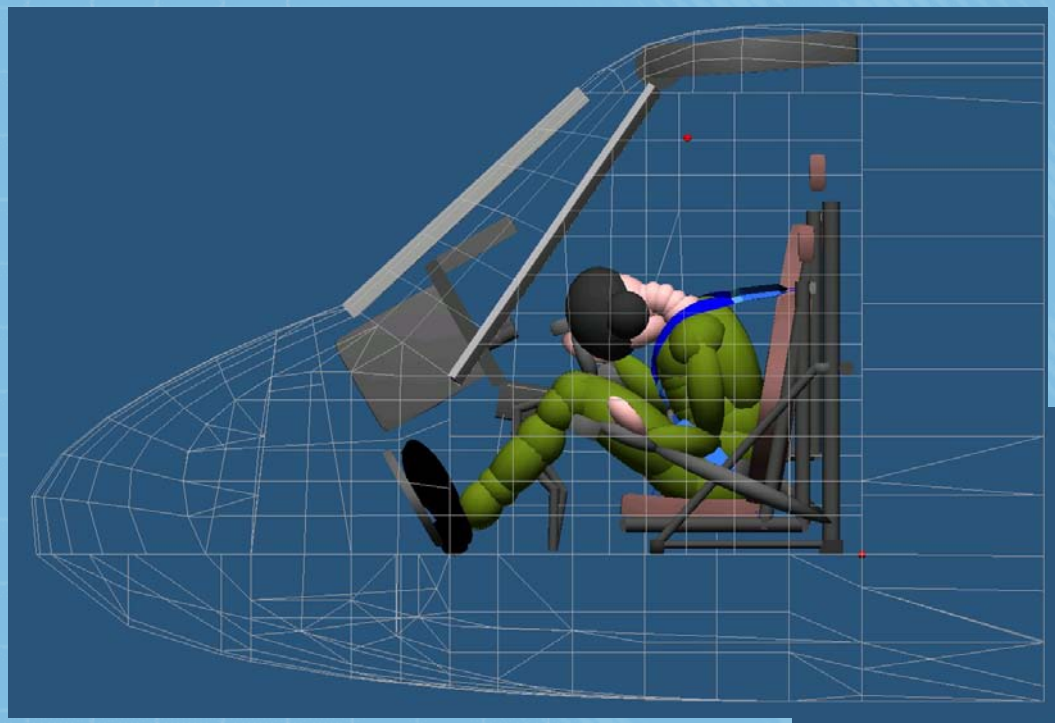


Standard Harness and Energy-absorbing Seat



Inflating Harness and Energy-absorbing Seat

H-60 Cockpit & Pilot: Maximum Head Flail in a 36G, 30° Pitch-down Crash

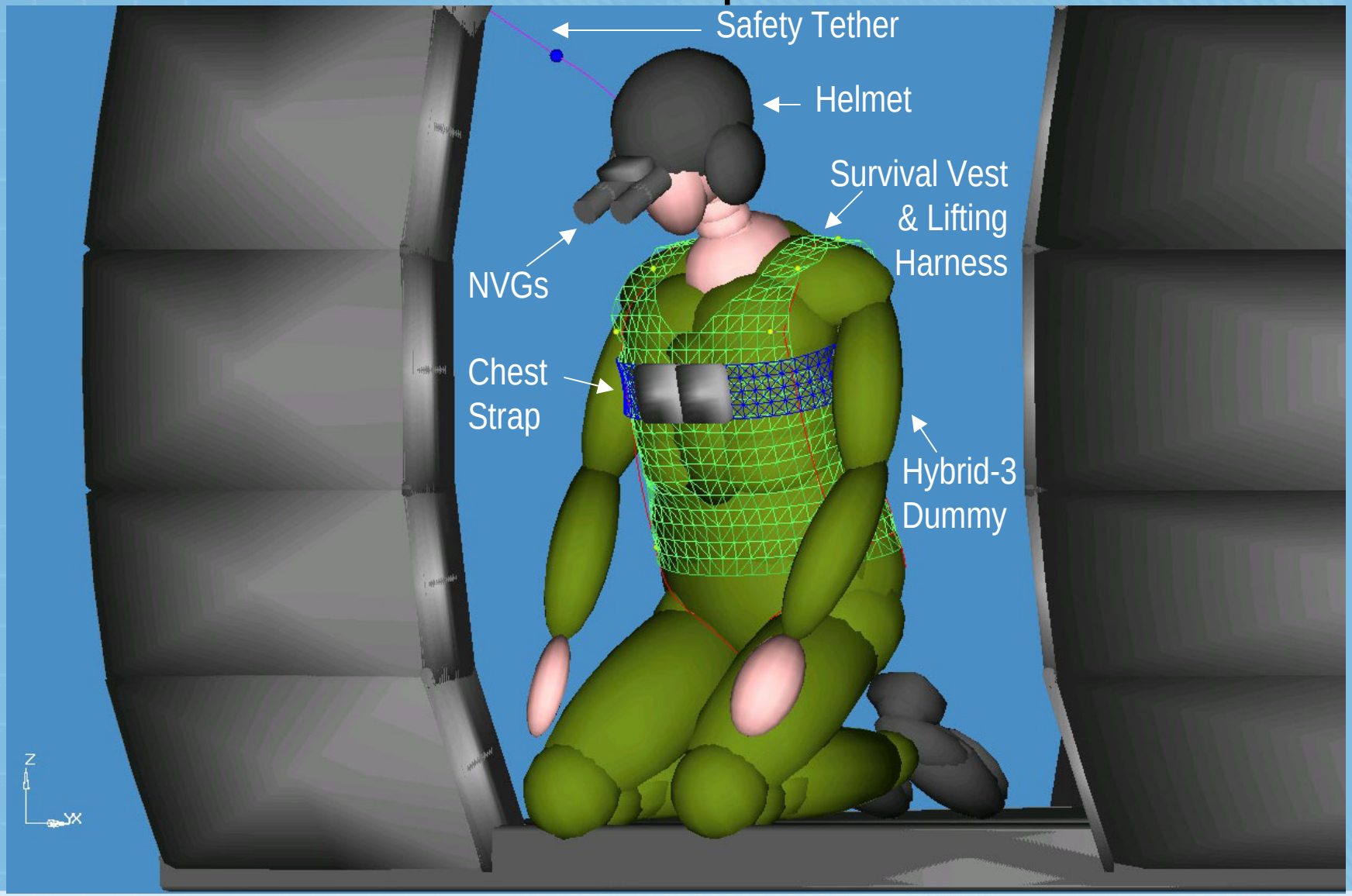


Standard Harness and Energy-absorbing Seat

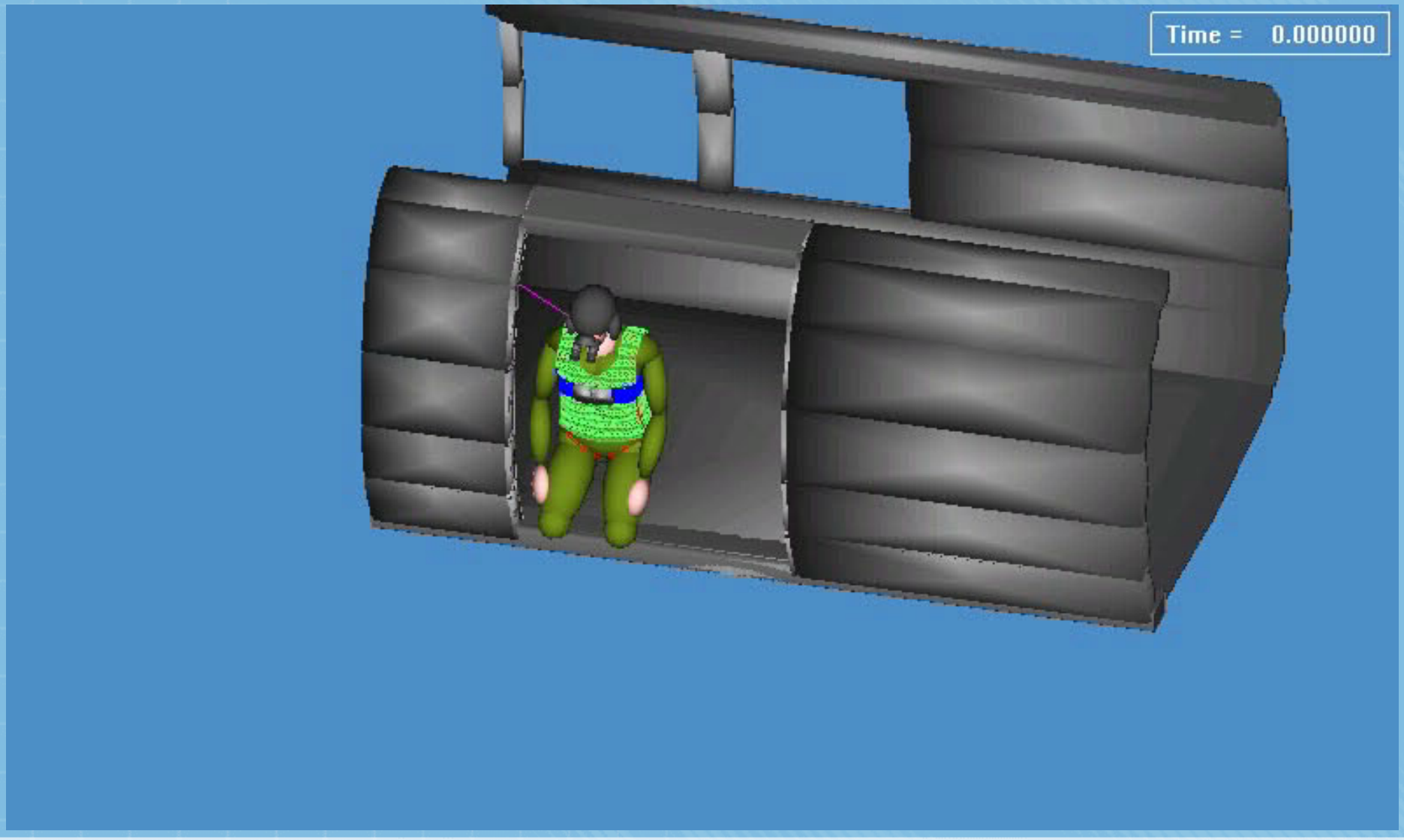
Inflating Harness and Energy-absorbing Seat

H-60 Seahawk Cabin & Mobile Crewman:
Mission Environment

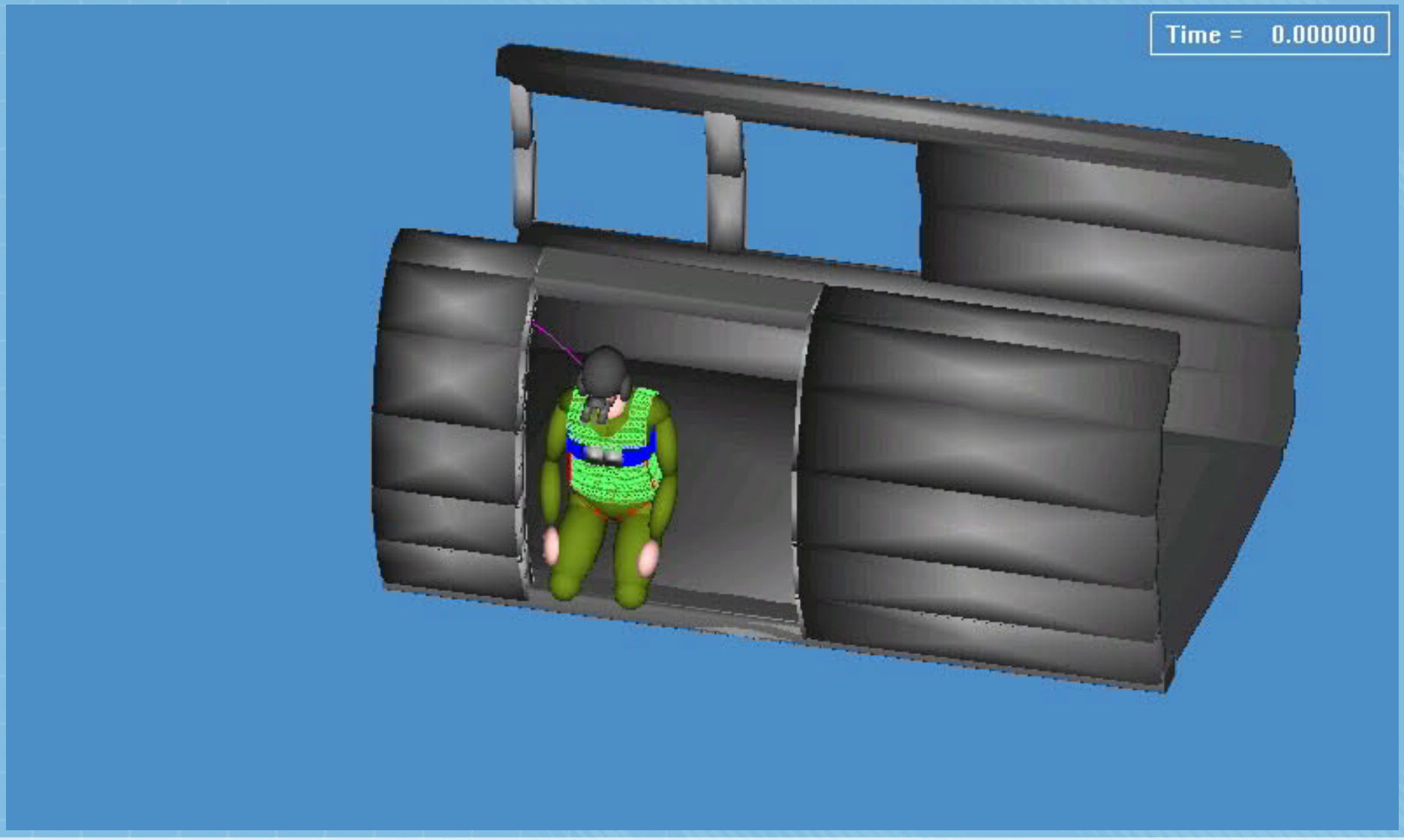
H-60 Cabin & Mobile Crewman:
Model Components



Current System with Full-Length Tether: Medium Severity Crash (10G Vertical, 10G Horizontal at 45º)

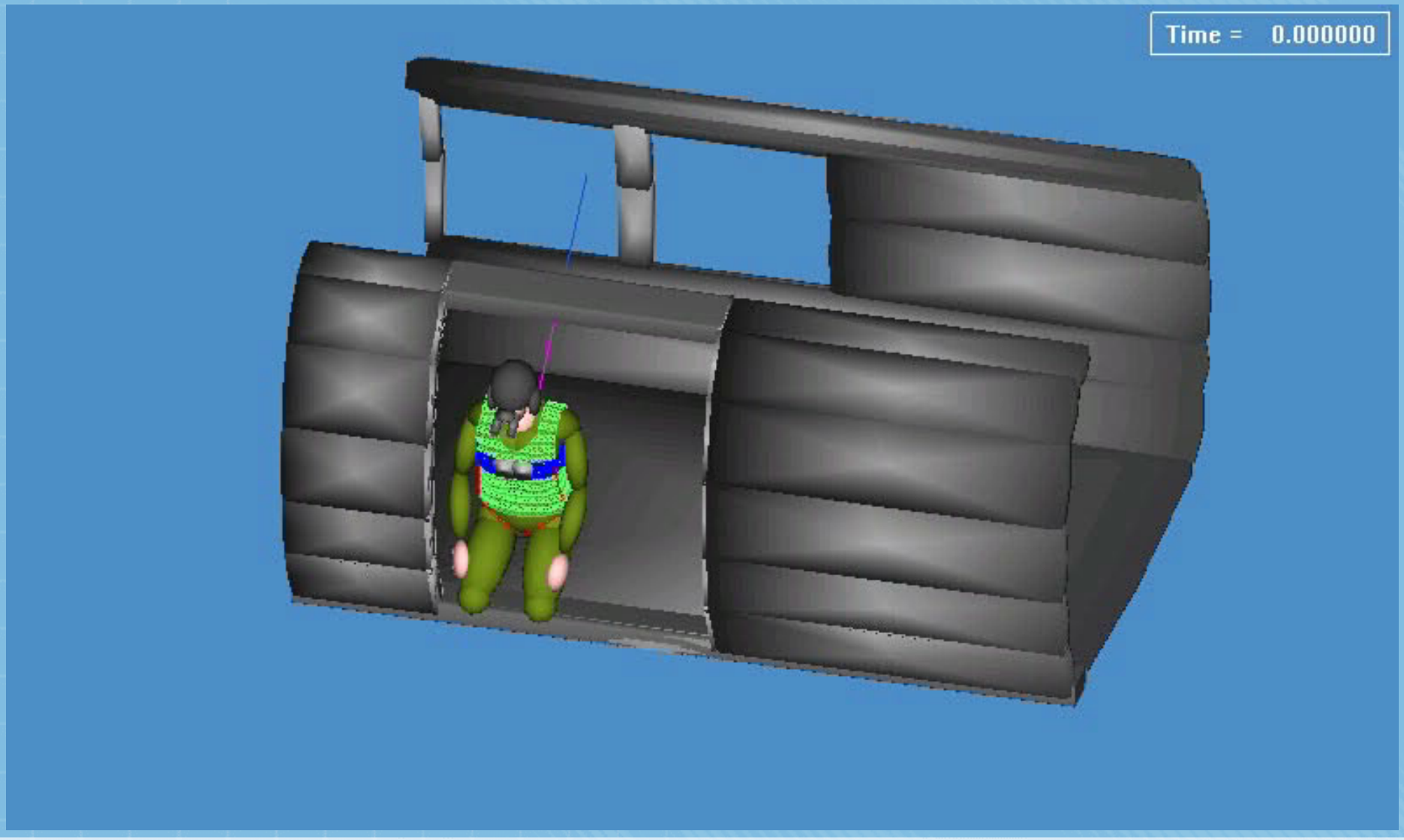


Current System with Short Tether: Medium Severity Crash (10G Vertical, 10G Horizontal at 45º)



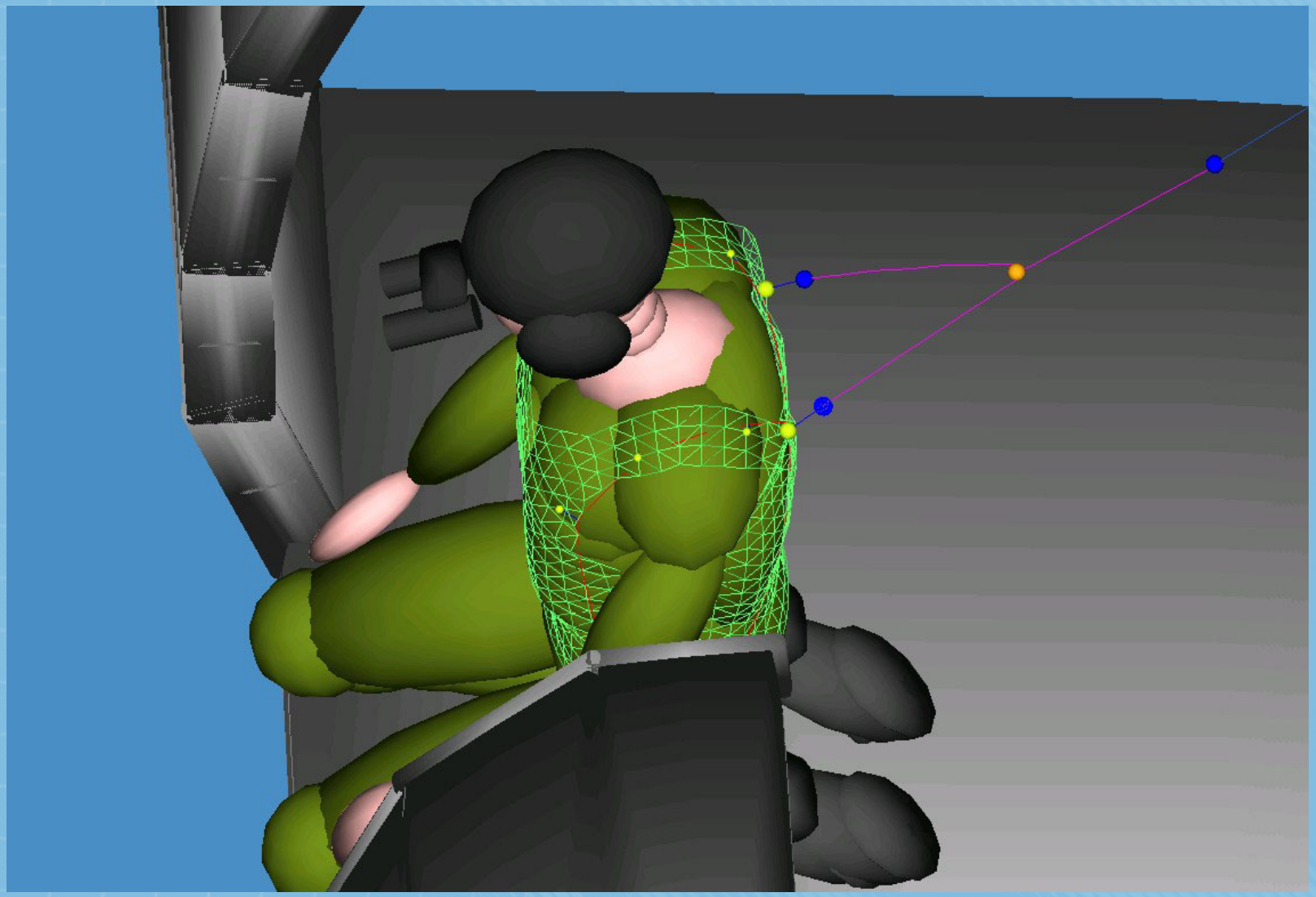
New System with Retractor and Better Anchor Point:

Medium Severity Crash (10G Vertical, 10G Horizontal at 45º)

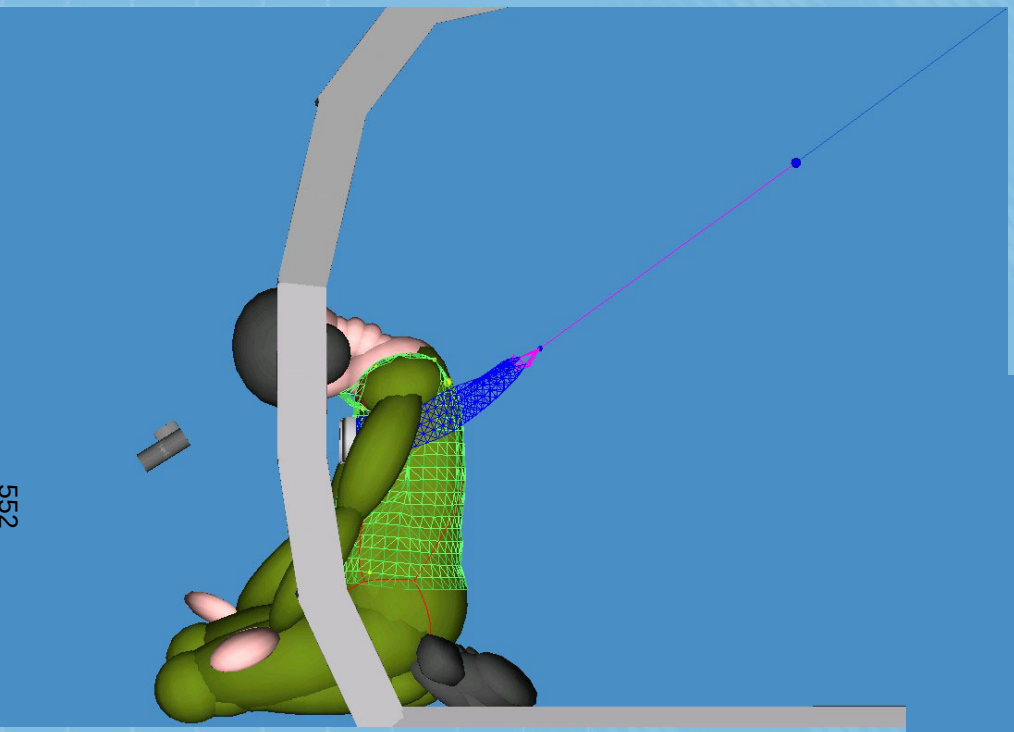


550

Future Safety Tether Improvements:
Connect Tether to Lifting Harness

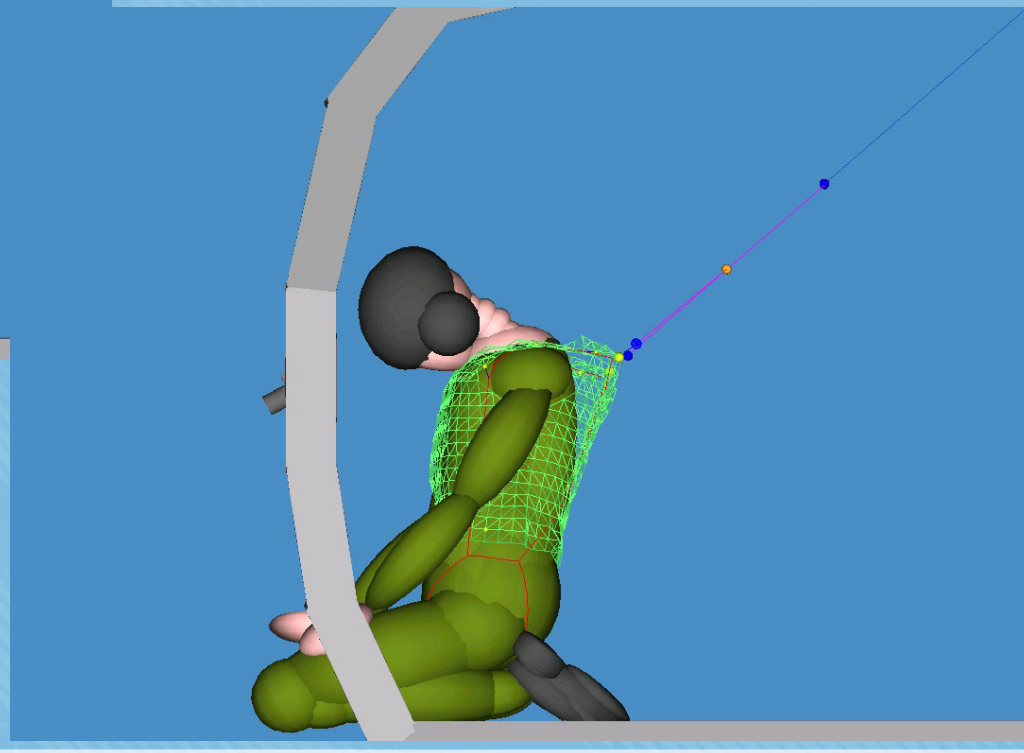


Chest Strap Tether vs. Harness Tether:
Torso Excursion and Chest Compression



Harness Interface

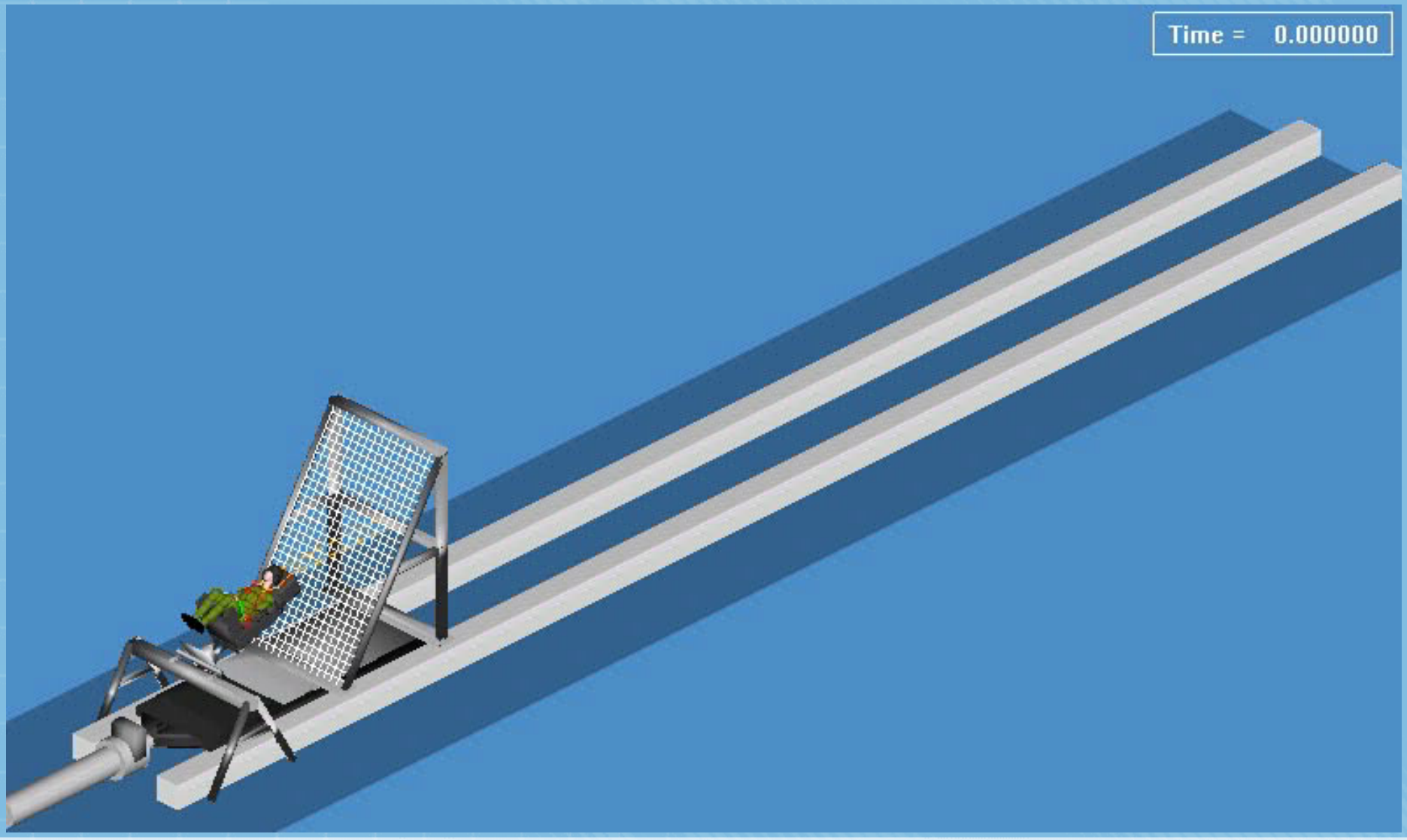
Chest Strap Interface



552

Ejection Seat Parachute Opening Snatch Loads:

Horizontal Accelerator (HA) Test



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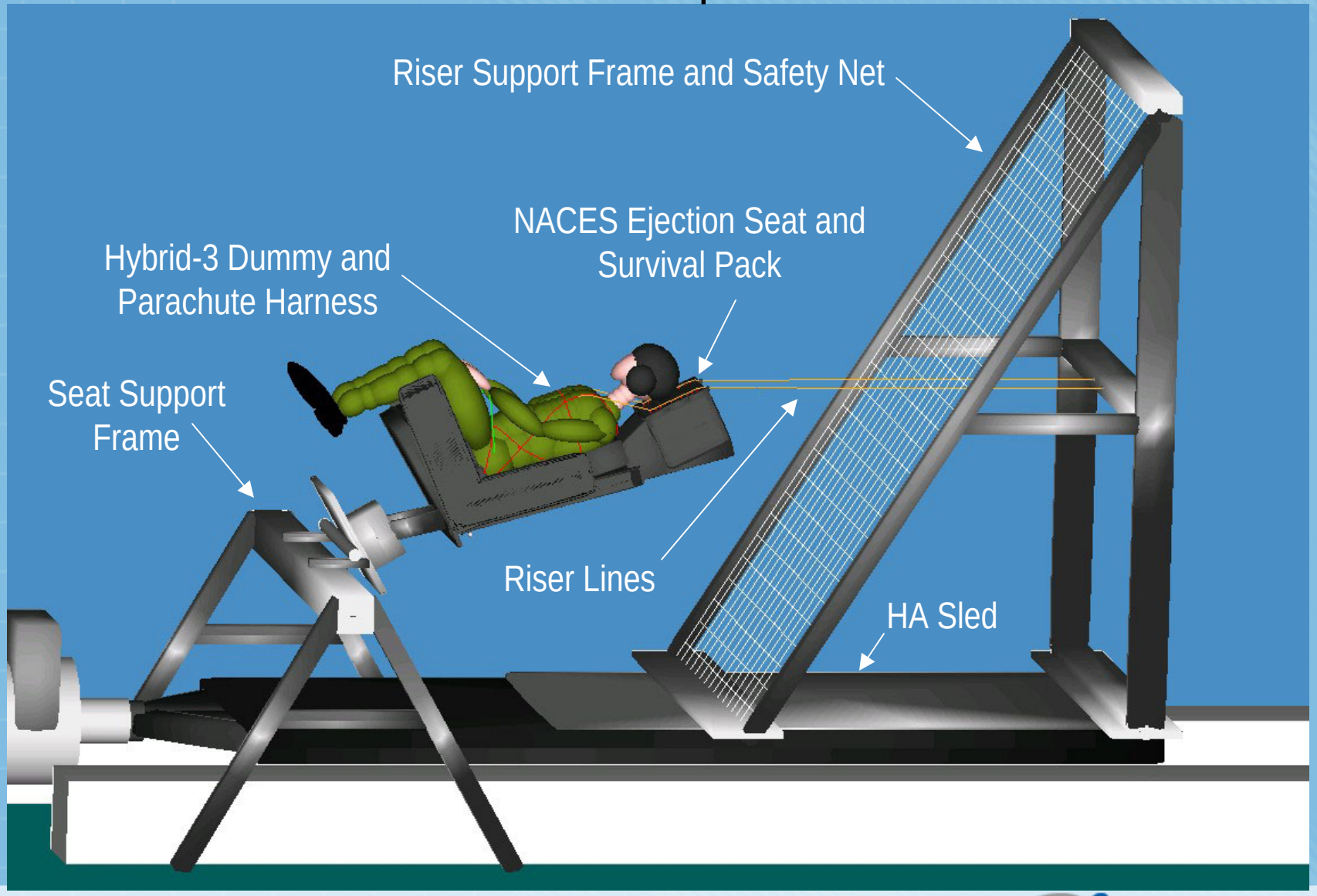
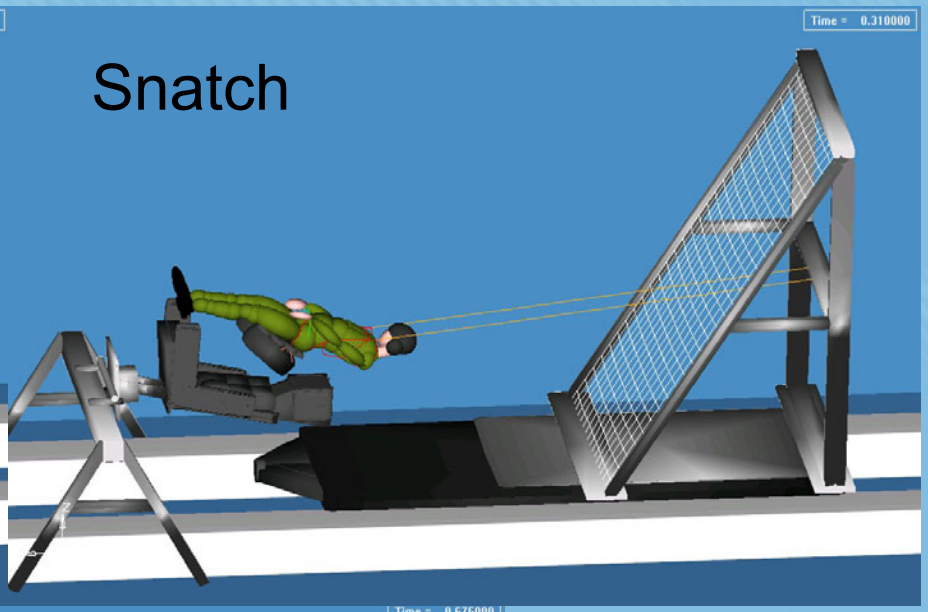
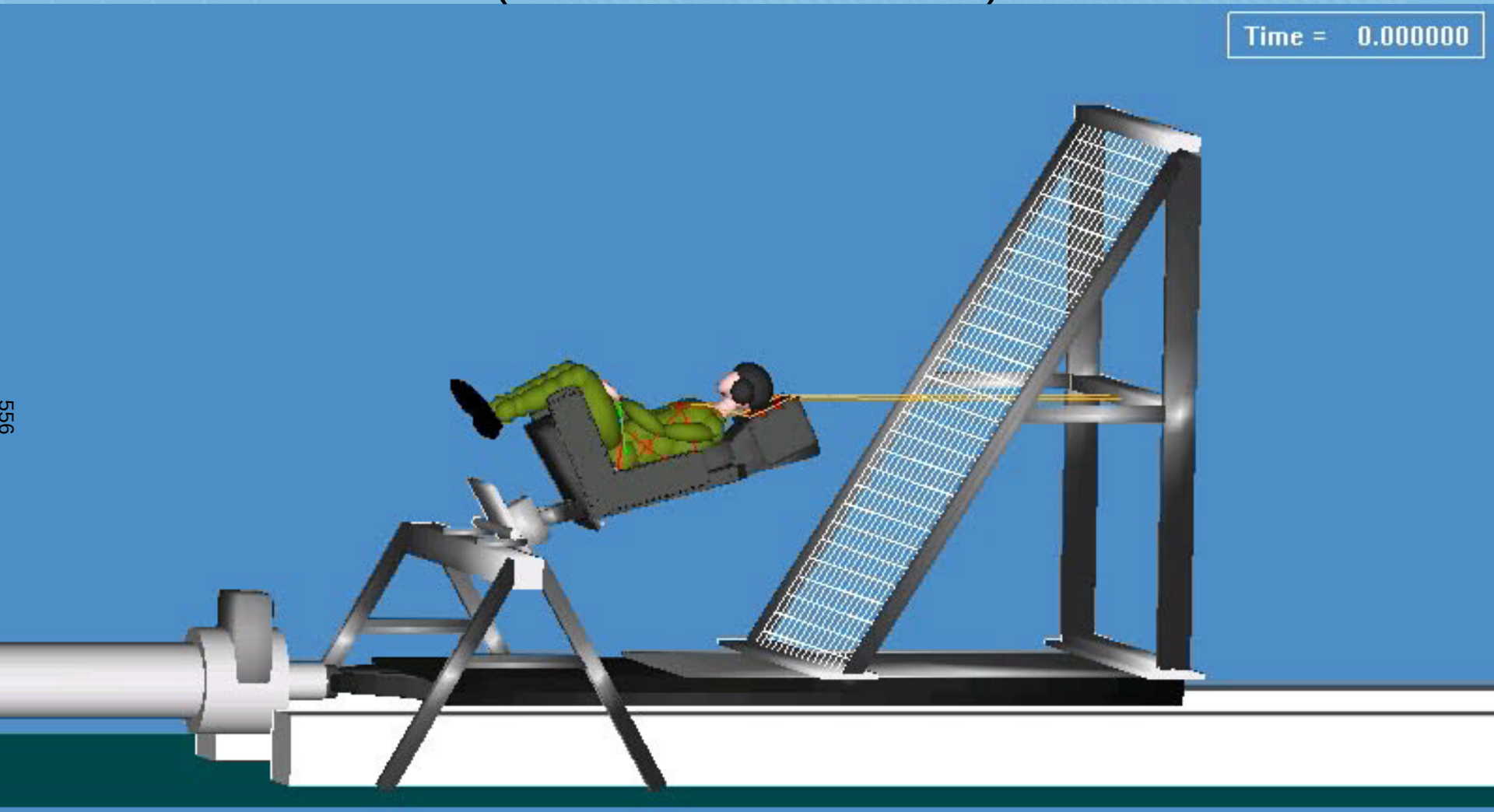


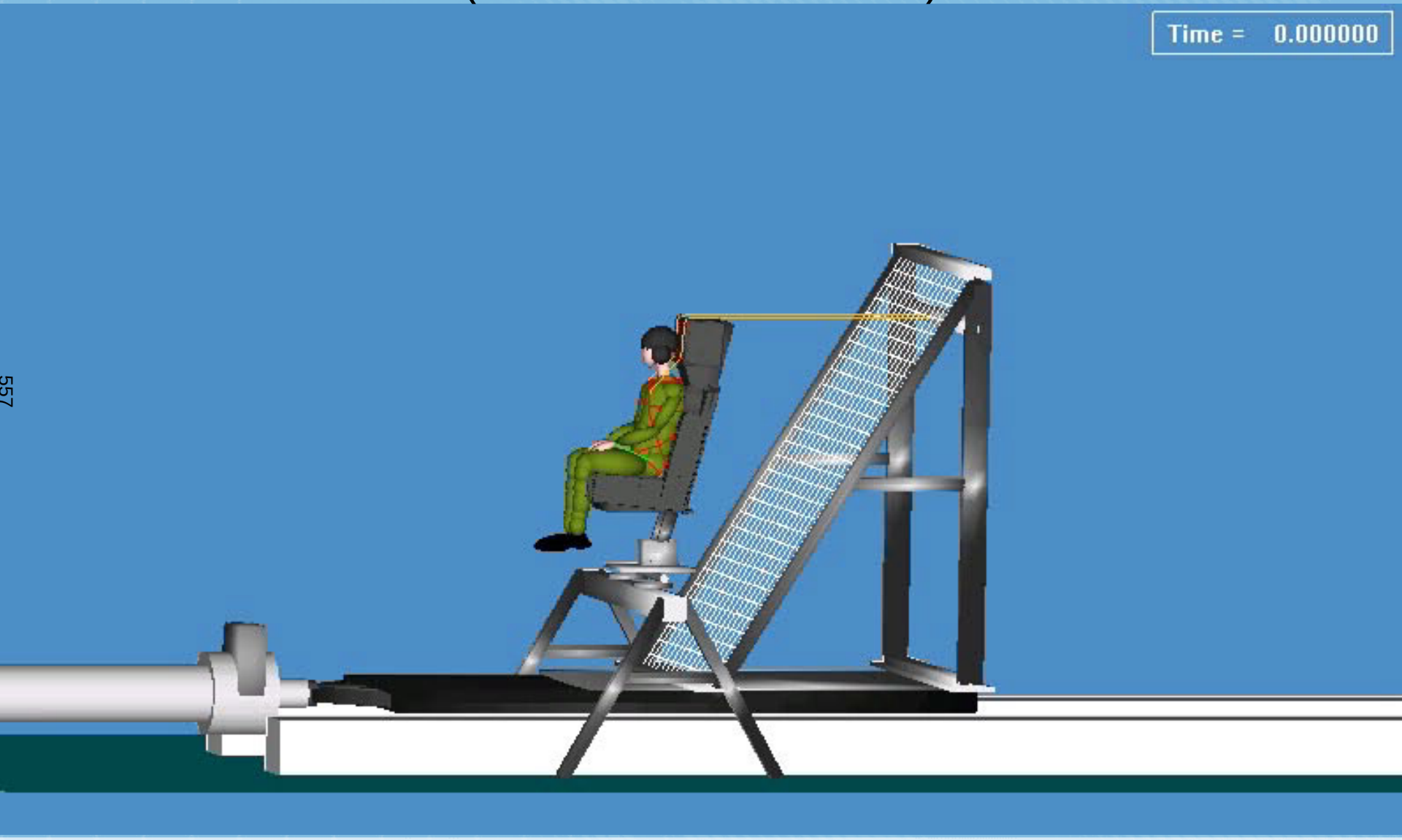
Parachute Opening Snatch Load Test: Phases



Snatch Load Test: 30º Pitch Simulation (Sled Reference Frame)

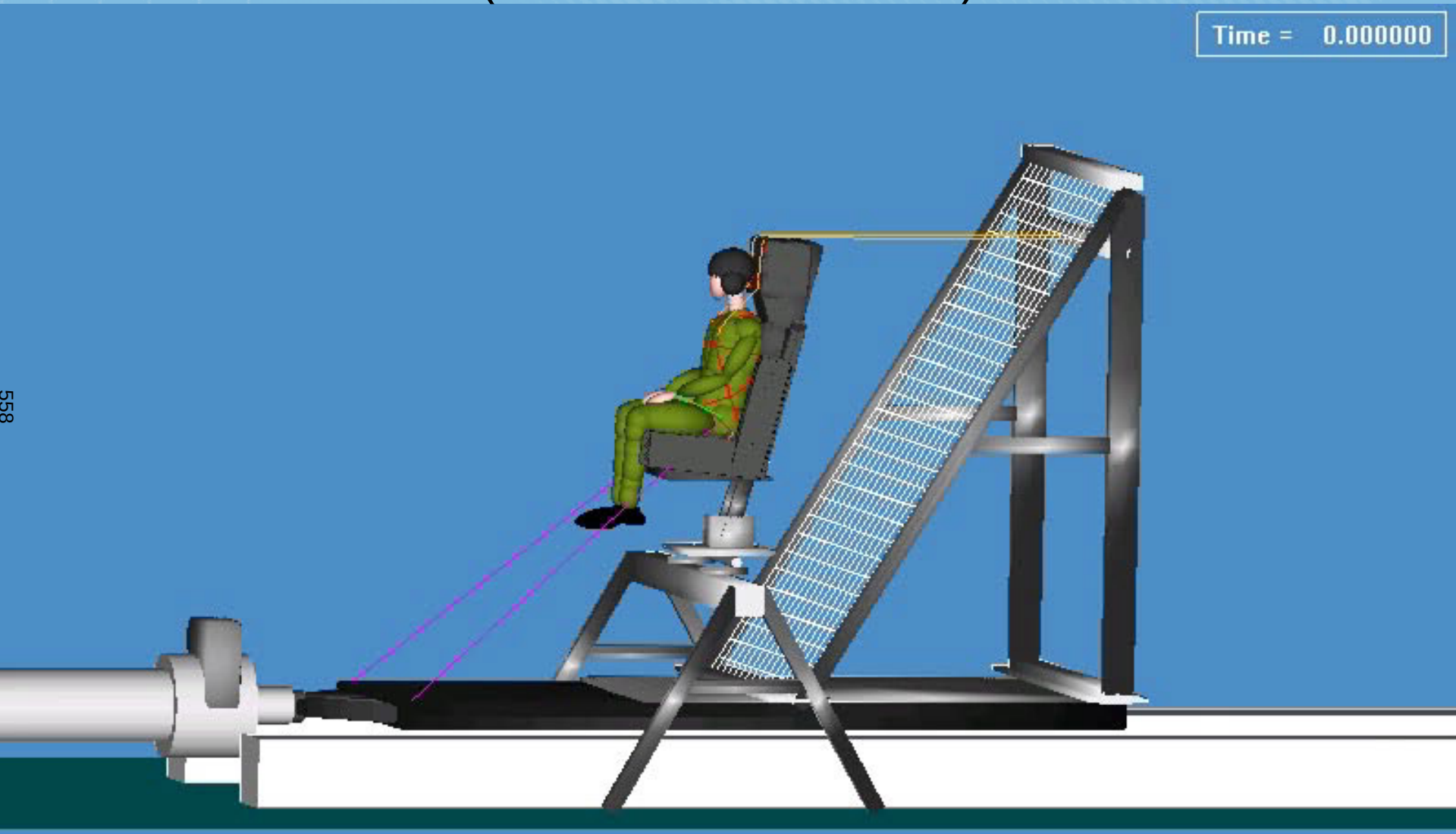


Snatch Load Test: 90º Pitch Simulation without Safety Tethers (Sled Reference Frame)



557

Snatch Load Test: 90º Pitch Simulation **with Safety Tethers**
(Sled Reference Frame)



558

Conclusions:
Benefits of Modeling and Simulation for Safety System Prototyping

- Understand the safety issues
- Evaluate current system performance
- Establish realistic performance bounds
- Explore potential improvements

Conclusions:
Benefits of Modeling and Simulation for Lab Experiment Prototyping

- Conceptualize proposed experiment
- Evaluate probable dynamics and loads
- Guide fixture fabrication
- Establish realistic test parameters
- Provide a reality check for test results